

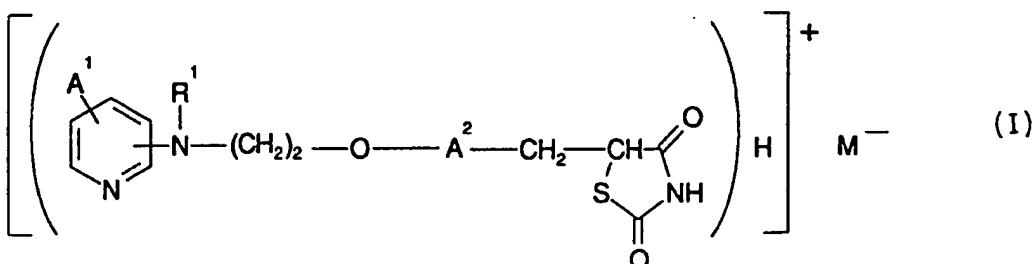
PCT

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: SUBSTITUTED THIAZOLIDINEDIONE DERIVATIVES



(57) Abstract

A compound of formula (I) or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, wherein: R<sup>1</sup> represents a hydrogen atom, an alkyl group, an acyl group, an aralkyl group, wherein the aryl moiety may be substituted or unsubstituted, or a substituted or unsubstituted aryl group; A<sup>1</sup> represents hydrogen or 1 to 4 optional substituents selected from the group consisting of: alkyl, alkoxy, aryl and halogen or A<sup>1</sup> represents two substituents on adjacent carbon atoms, which substituents together with the carbon atoms to which they are attached form a substituted or unsubstituted aryl group; A<sup>2</sup> represents a benzene ring having 1 to 3 optional substituents; and M<sup>-</sup> represents a counter-ion; a process for preparing such a compound, a pharmaceutical composition comprising such a compound and the use of such a compound and composition in medicine.

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## SUBSTITUTED THIAZOLIDINEDIONE DERIVATIVES

This invention relates to certain novel compounds, to a process for preparing  
 5 such compounds, to pharmaceutical compositions containing such compounds and to  
 the use of such compounds and compositions in medicine.

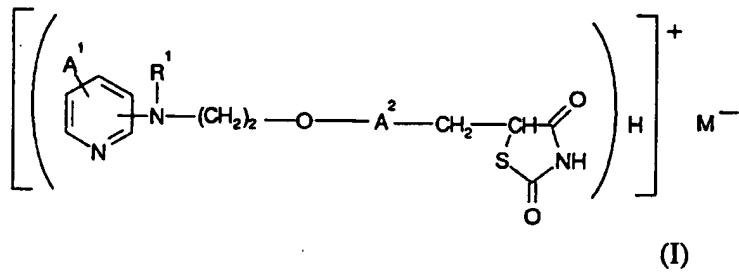
European Patent Application, Publication Number 0,306,228 relates to certain  
 thiazolidinedione derivatives disclosed as having hypoglycaemic and hypolipidaemic  
 activity.

10 It is now surprisingly indicated that a specific group of compounds from  
 within formula (I) of EP-A-0,306,228 have improved selectivity of action and are  
 therefore of particular use in the treatment of Type II diabetes. These compounds are  
 also indicated to be of particular use for the treatment and/or prophylaxis of other  
 diseases including hyperlipidaemia, hypertension and cardiovascular disease,  
 15 especially atherosclerosis. In addition these compounds are considered to be useful  
 for treating certain eating disorders, in particular the regulation of appetite and food  
 intake in subjects suffering from disorders associated with under-eating, such as  
 anorexia nervosa, and disorders associated with over-eating, such as obesity and  
 anorexia bulimia.

20 These compounds show good aqueous stability and good stability in the solid  
 form, certain of these compounds are indicated to be particularly stable. In addition  
 these compounds are significantly more soluble in water than the corresponding free  
 base.

25 The surprising and advantageous stability and aqueous solubility of these  
 compounds provides for significant formulation and bulk handling advantages.

Accordingly, the present invention provides a compound of formula (I):



30

or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof,  
 wherein:

R¹ represents a hydrogen atom, an alkyl group, an acyl group, an aralkyl  
 group, wherein the aryl moiety may be substituted or unsubstituted, or a substituted or

- 2 -

unsubstituted aryl group; A<sup>1</sup> represents hydrogen or 1 to 4 optional substituents selected from the group consisting of: alkyl, alkoxy, aryl and halogen or A<sup>1</sup> represents two substituents on adjacent carbon atoms, which substituents together with the carbon atoms to which they are attached form a substituted or unsubstituted 5 aryl group; A<sup>2</sup> represents a benzene ring having 1 to 3 optional substituents; and M<sup>-</sup> represents a counter-ion.

Suitable counter-ions M<sup>-</sup> include ions provided by pharmaceutically acceptable acids.

A suitable source of counter-ions M<sup>-</sup> is provided by those pharmaceutically acceptable acids having a pK<sub>a</sub> in the range of from 0.1 to 4.5 and especially in the range of from 1.75 to 2.5.

Favoured pharmaceutically acceptable acids include mineral acids, such as hydrobromic, hydrochloric and sulphuric acids, and organic acids, such as methanesulphonic, tartaric and maleic acids, especially tartaric and maleic acid.

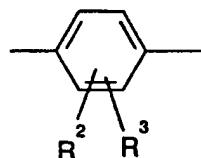
15 A preferred counter-ion is the maleate ion HOOC.CH=CH.COO<sup>-</sup>.

Preferably, A<sup>1</sup> is hydrogen.

Suitable optional substituents for the moiety A<sup>2</sup> include up to three substituents selected from halogen, substituted or unsubstituted alkyl or alkoxy.

Favourably, A<sup>2</sup> represents a moiety of formula (e):

20



(e)

wherein R<sup>2</sup> and R<sup>3</sup> each independently represent hydrogen, halogen, substituted or 25 unsubstituted alkyl or alkoxy.

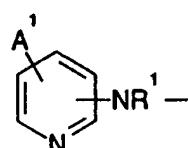
Suitably, R<sup>2</sup> and R<sup>3</sup> each independently represent hydrogen, halogen, alkyl or alkoxy.

Preferably, R<sup>2</sup> and R<sup>3</sup> each represent hydrogen.

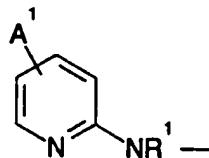
Suitably, R<sup>1</sup> represents hydrogen, alkyl, acyl, especially acetyl, or benzyl.

30 Preferably, R<sup>1</sup> represents an alkyl group, for example a methyl group.

Preferably the moiety :



in formula (I) is a moiety of formula :



5

wherein A¹ and R¹ are as defined above

A preferred compound of formula (I) is 5-[4-[2-(N-methyl-N-(2-pyridyl)amino)ethoxy]benzyl]thiazolidine-2,4-dione maleic acid salt.

The compounds of formula (I) are salts. The present invention extends to all forms of such salts including those provided by association of the salting hydrogen with all possible salt forming parts of the molecule and especially that provided by association with the pyridine nitrogen.

As indicated above a compound of formula (I) may exist in one of several tautomeric forms, all of which are encompassed by the present invention. It will be appreciated that the present invention encompasses all of the isomeric forms of the compounds of formula (I) and the pharmaceutically acceptable salts thereof, including any stereoisomeric forms thereof, whether as individual isomers or as mixtures of isomers.

When used herein the term 'aryl' includes phenyl and naphthyl optionally substituted with up to five, preferably up to three, groups selected from halogen, alkyl, phenyl, alkoxy, haloalkyl, hydroxy, nitro, alkoxy carbonyl, alkoxy carbonyl alkyl, alkyl carbonyloxy, or alkyl carbonyl groups.

When used herein the term 'halogen' refers to fluorine, chlorine, bromine and iodine; preferably chlorine.

Suitable alkyl groups, including alkyl groups *per se* and alkyl groups that form part of other groups such as alkoxy groups, are C<sub>1</sub>-12 alkyl groups having straight or branched carbon chains, especially C<sub>1</sub>-6 alkyl groups e.g. methyl, ethyl, n-propyl, iso-propyl, n-butyl, isobutyl or tert-butyl groups.

Suitable substituents for any alkyl group include those indicated above in relation to the term "aryl".

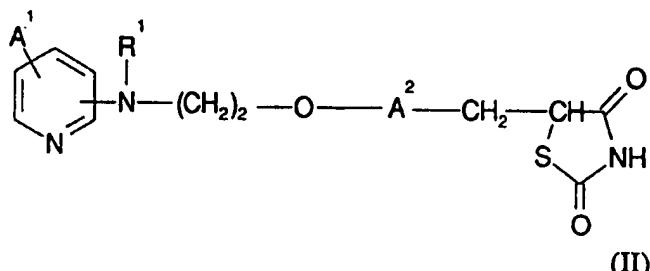
Suitable acyl groups include alkyl carbonyl groups.

Suitable pharmaceutically acceptable solvates include hydrates.

In a further aspect the present invention also provides a process for the preparation of a compound of formula (I), or a tautomeric form thereof, and/or a

- 4 -

pharmaceutically acceptable solvate thereof, which process comprises reacting a compound of formula (II):



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wherein R<sup>1</sup>, A<sup>1</sup> and A<sup>2</sup> are as defined in relation to formula (I), with a source of above defined counter-ion M<sup>-</sup>; and thereafter if required preparing a pharmaceutically acceptable solvate thereof.

10       A suitable source of a counter-ion M<sup>-</sup> is a pharmaceutically acceptable acid.

A suitable source of counter-ions includes pharmaceutically acceptable acids having a pK<sub>a</sub> in the range of from 1.5 to 4.5, especially in the range of from 1.75 to 2.5.

15       Favoured pharmaceutically acceptable acids include mineral acids, such as hydrobromic, hydrochloric and sulphuric acids, and organic acids, such as methanesulphonic, tartaric and maleic acids.

A preferred source of a counter-ion is maleic acid.

20       The reaction between the compound of formula (I) and the source of counter-ion M<sup>-</sup> is generally carried out under conventional salt forming conditions, for example by admixing the compound of formula (I) and the source of counter-ion M<sup>-</sup>, suitably in approximately equimolar amounts but preferably using a slight excess of the source of counter-ion M<sup>-</sup>, in a solvent, generally a C<sub>1</sub>-4 alkanolic solvent such as ethanol, at any temperature which provides a suitable rate of formation of the required product, generally at an elevated temperature for example at the reflux 25 temperature of the solvent and thereafter crystallising the required product.

Pharmaceutically acceptable solvates of the compound of formula (I) may be prepared using conventional chemical procedures.

The compound of formula (II) may be prepared according to methods disclosed in EP-A-0306228.

30       Suitable sources of counter-ion are known commercially available sources, such as maleic acid, or the required source may be prepared according to known procedures.

Where appropriate the isomeric forms of the compounds of formula (I) and the pharmaceutically acceptable salts thereof may be prepared as individual isomers using conventional chemical procedures.

The stability of the compounds of the invention may be determined using 5 conventional quantitative analytical methods: For example the stability of the compounds in the solid form may be determined by using accelerated stability tests such as differential scanning calorimetry (DSC), thermogravimetric analysis (TGA) and isothermal testing at elevated temperatures including conventional storage tests wherein the test compounds are stored under controlled conditions of temperature and 10 humidity over known periods of time. Quantitative analysis of the test compounds, against appropriate reference standards before, during and after the storage period allows the stability of the test compound to be determined.

As stated the compounds of the invention are significantly more soluble in water than the corresponding free base. Thus a convenient method for determining 15 the stability of the compounds of the invention in aqueous solution involves determining the degree of precipitation of the parent free base from an aqueous solution of the test compound at known conditions of temperature and over known periods of time. We have found that the compounds of formula (I) show good aqueous stability. In particular the compounds of formula (I) wherein M<sup>+</sup> represents 20 maleate or tartrate are particularly stable in aqueous solution. Most surprisingly, the compounds of formula (I) wherein M<sup>+</sup> represents a maleate ion, HOOC.CH=CH.COO<sup>-</sup>, were found to be particularly stable in aqueous solution.

The quantitative analysis of the test compounds in the above mentioned tests may be carried out using conventional methods, generally chromatographic methods 25 such as high pressure liquid chromatography.

As mentioned above the compounds of the invention are indicated as having useful therapeutic properties:

The present invention accordingly provides a compound of formula (I), and/or 30 a pharmaceutically acceptable solvate thereof, for use as an active therapeutic substance.

Thus the present invention provides a compound of formula (I), or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, for use in the treatment of and/or prophylaxis of hyperglycaemia.

In a further aspect the present invention also provides a compound of formula 35 (I), or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, for use in the treatment and/or prophylaxis of hyperlipidaemia.

As indicated hereinbefore the present invention also provides a compound of formula (I) or a tautomeric form thereof and/or a pharmaceutically acceptable solvate

thereof for use in the treatment of hypertension, cardiovascular disease and certain eating disorders.

Cardiovascular disease includes in particular atherosclerosis.

5 Certain eating disorders include in particular the regulation of appetite and food intake in subjects suffering from disorders associated with under-eating, such as anorexia nervosa, and disorders associated with over-eating, such as obesity and anorexia bulimia.

A compound of formula (I), or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, may be administered *per se* or, 10 preferably, as a pharmaceutical composition also comprising a pharmaceutically acceptable carrier.

Accordingly, the present invention also provides a pharmaceutical composition comprising a compound of formula (I), or a tautomeric form thereof, or a pharmaceutically acceptable solvate thereof, and a pharmaceutically acceptable 15 carrier therefor.

As used herein the term 'pharmaceutically acceptable' embraces compounds, compositions and ingredients for both human and veterinary use: for example the term 'pharmaceutically acceptable salt' embraces a veterinary acceptable salt.

The composition may, if desired, be in the form of a pack accompanied by 20 written or printed instructions for use.

Usually the pharmaceutical compositions of the present invention will be adapted for oral administration, although compositions for administration by other routes, such as by injection and percutaneous absorption are also envisaged.

Particularly suitable compositions for oral administration are unit dosage 25 forms such as tablets and capsules. Other fixed unit dosage forms, such as powders presented in sachets, may also be used.

In accordance with conventional pharmaceutical practice the carrier may comprise a diluent, filler, disintegrant, wetting agent, lubricant, colourant, flavourant or other conventional adjuvant.

30 Typical carriers include, for example, microcrystalline cellulose, starch, sodium starch glycollate, polyvinylpyrrolidone, polyvinylpolypyrrolidone, magnesium stearate or sodium lauryl sulphate.

Most suitably the composition will be formulated in unit dose form. Such unit dose will normally contain an amount of the active ingredient in the range of from 0.1 35 to 1000 mg, more usually 0.1 to 500 mg, and more especially 0.1 to 250 mg.

The present invention further provides a method for the treatment and/or prophylaxis of hyperglycaemia in a human or non-human mammal which comprises administering an effective, non-toxic, amount of a compound of formula (I), or a

tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof to a hyperglycaemic human or non-human mammal in need thereof.

The present invention further provides a method for the treatment of hyperlipidaemia in a human or non-human mammal, which comprises administering 5 an effective, non-toxic, amount of a compound of formula (I), or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, to a hyperlipidaemic human or non-human mammal in need thereof.

Conveniently, the active ingredient may be administered as a pharmaceutical 10 composition hereinbefore defined, and this forms a particular aspect of the present invention.

In the treatment and/or prophylaxis of hyperglycaemic humans, and/or the 15 treatment and/or prophylaxis of hyperlipidaemic human, the compound of formula (I), or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, may be taken in doses, such as those described above, one to six times a day in a manner such that the total daily dose for a 70 kg adult will generally be in the range 15 of from 0.1 to 6000 mg, and more usually about 1 to 1500 mg.

In the treatment and/or prophylaxis of hyperglycaemic non-human mammals, especially dogs, the active ingredient may be administered by mouth, usually once or twice a day and in an amount in the range of from about 0.025 mg/kg to 25 mg/kg, 20 for example 0.1 mg/kg to 20 mg/kg. Similar dosage regimens are suitable for the treatment and/or prophylaxis of hyperlipidaemia in non-human mammals.

The dosages regimens for the treatment of hypertension, cardiovascular disease and eating disorders will generally be those mentioned above in relation to hyperglycaemia.

25 In a further aspect the present invention provides the use of a compound of formula (I), or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, for the manufacture of a medicament for the treatment and/or prophylaxis of hyperglycaemia.

The present invention also provides the use of a compound of formula (I), or a 30 tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, for the manufacture of a medicament for the treatment and/or prophylaxis of hyperlipidaemia, hypertension, cardiovascular disease or certain eating disorders.

The following Example illustrates the invention but does not limit it in any way.

**Example 1****5-[4-[2-(N-Methyl-N-(2-pyridyl)amino)ethoxy]benzyl]thiazolidine-2,4-dione,  
5 maleic acid salt**

5-[4-[2-(N-Methyl-N-(2-pyridyl)amino)ethoxy]benzyl]thiazolidine-2,4-dione (470g) and maleic acid (137g) were dissolved in ethanol (41.) at boiling. The hot solution was filtered via diatomaceous earth and was then allowed to cool slowly with gentle agitation. After leaving in a refrigerator at 0-5°C for several hours, the maleate salt was filtered off, washed with ethanol and dried in vacuo at 50° to give 446g (73%) of product, m.p.120-121°C.

1H NMR δ (d<sub>6</sub>-DMSO): 3.0-3.35 (2H, complex); 3.10 (3H, s); 3.95 (2H, t); 4.15 (2H, t); 4.85 (1H, complex); 6.20 (2H, s); 6.65 (1H, t); 6.85 (3H, complex); 7.15 (2H, d) 7.65 (1H, t); 8.05 (1H, complex); 11.85-12.1 (1H, broad, exchanges with D<sub>2</sub>O).

A very broad signal was observed in the range 2-5ppm which is thought to be due to residual water from the solvent and the exchangeable carboxylic acid protons.

**Example 2****5-[4-[2-(N-Methyl-N-(2-pyridyl)amino)ethoxy]benzyl]thiazolidine-2,4-dione,  
maleic acid salt**

5-[4-[2-(N-Methyl-N-(2-pyridyl)amino)ethoxy]benzyl]thiazolidine-2,4-dione, maleic acid salt (294.6g, 0.825M) and maleic acid (95.8g 0.825m) were stirred in refluxing ethanol (2.7l) until all the solid had dissolved. Decolourising charcoal was added and the hot solution filtered through celite, allowed to cool to room temperature with stirring. After cooling in a refrigerator at 0-5°C for several hours, the title compound was filtered, collected and dried at 50°C under vacuum overnight to give 364.1g (87%) of product, m.p. 119 - 119.5°C.

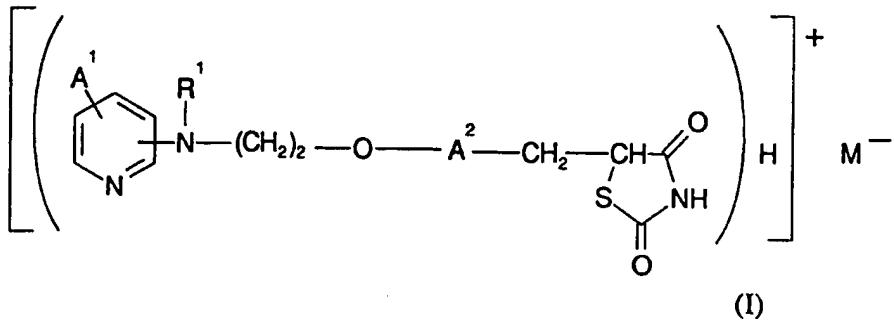
The 1H NMR spectra was as for Example 1.

- 9 -

**Claims**

1. A compound of formula (I):

5



or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, wherein:

10

$\text{R}^1$  represents a hydrogen atom, an alkyl group, an acyl group, an aralkyl group, wherein the aryl moiety may be substituted or unsubstituted, or a substituted or unsubstituted aryl group;

15  $\text{A}^1$  represents hydrogen or 1 to 4 optional substituents selected from the group consisting of: alkyl, alkoxy, aryl and halogen or  $\text{A}^1$  represents two substituents on adjacent carbon atoms, which substituents together with the carbon atoms to which they are attached form a substituted or unsubstituted aryl group;

$\text{A}^2$  represents a benzene ring having 1 to 3 optional substituents; and

$\text{M}^-$  represents a counter-ion.

20

2. A compound according to claim 1, wherein  $\text{M}^-$  is provided by a pharmaceutically acceptable acid having a  $\text{pK}_a$  in the range of from 0.1 to 4.5.

25 3. A compound according to claim 1 or claim 2, wherein  $\text{M}^-$  is provided by a pharmaceutically acceptable acid having a  $\text{pK}_a$  in the range of from 1.75 to 2.5.

4. A compound according to any one of claims 1 to 3, wherein  $\text{M}^-$  is the maleate ion  $\text{HOOC}.\text{CH}=\text{CH}.\text{COO}^-$ .

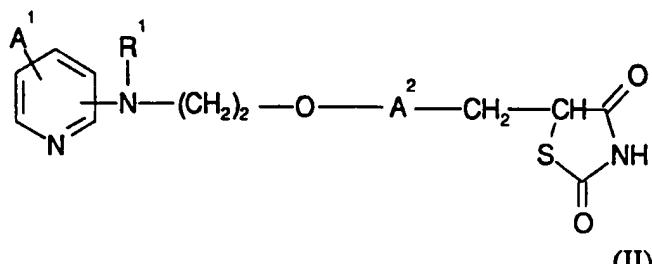
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5. A compound according to claim 1, being 5-[4-[2-(N-methyl-N-(2-pyridyl)amino)ethoxy]benzyl]thiazolidine-2,4-dione, maleic acid salt

6. A process for the preparation of a compound of formula (I), or a tautomeric

- 10 -

form thereof, and/or a pharmaceutically acceptable solvate thereof, which process comprises reacting a compound of formula (II):



5

wherein R<sup>1</sup>, A<sup>1</sup> and A<sup>2</sup> are as defined in relation to formula (I), with a source of counter-ion M<sup>-</sup>; and thereafter if required preparing a pharmaceutically acceptable solvate thereof.

10

7. A process according to claim 6, wherein the source of counter-ion M<sup>-</sup> includes pharmaceutically acceptable acids having a pK<sub>a</sub> in the range of from 1.5 to 4.5 or from 1.75 to 2.5.

15

8. A process according to claim 6, wherein the source of a counter-ion M<sup>-</sup> is maleic acid.

20

9. A pharmaceutical composition comprising a compound of formula (I), or a tautomeric form thereof, or a pharmaceutically acceptable solvate thereof, and a pharmaceutically acceptable carrier therefor.

25

10. A compound of formula (I), or a tautomeric form thereof, or a pharmaceutically acceptable solvate thereof, for use as an active therapeutic substance.

30

11. A compound of formula (I), or a tautomeric form thereof and/or a pharmaceutically acceptable solvate thereof, for use in the treatment of and/or prophylaxis of hyperglycaemia, hyperlipidaemia, hypertension, cardiovascular disease and certain eating disorders.

35

12. A method for the treatment and/or prophylaxis of hyperglycaemia, hyperlipidaemia, hypertension, cardiovascular disease and certain eating disorders in a human or non-human mammal which comprises administering an effective, non-toxic, amount of a compound of formula (I), or a tautomeric form thereof and/or

- 11 -

a pharmaceutically acceptable solvate thereof to a human or non-human mammal in need thereof.

13. The use of a compound of formula (I), or a tautomeric form thereof and/or a  
5 pharmaceutically acceptable solvate thereof, for the manufacture of a medicament for  
the treatment and/or prophylaxis of hyperglycaemia, hyperlipidaemia, hypertension,  
cardiovascular disease and certain eating disorders.

## INTERNATIONAL SEARCH REPORT

Int'l Application No

PCT/GB 93/01853

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 5 C07D417/12 A61K31/425 A61K31/44

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
 IPC 5 C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 306 228 (BEECHAM GROUP PLC) 8 March 1989 cited in the application see pages 38 and 39, examples 30, 31 see claims 1, 12, 14-17 ----	1, 9-13
A	EP,A,0 419 035 (BEECHAM GROUP PLC) 27 March 1991 see claims -----	1, 9-13

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

## \* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

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Date of the actual completion of the international search	Date of mailing of the international search report
17 November 1993	30.11.93
Name and mailing address of the ISA  European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Authorized officer  HENRY, J

**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/GB93/01853

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:  
Although claim 12 is directed to a method of treatment of the human body the search has been carried out and based on the alleged effects of the compounds.
2.  Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3.  Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

The additional search fees were accompanied by the applicant's protest.  
 No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 93/01853

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